



WATERLOO REGION LIGHT RAIL TRANSIT – OVERVIEW AND DESIGN CHALLENGE

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ABSTRACT

The Region of Waterloo rapid transit system (“ION”) will connect the Region’s three major urban centres - the cities of Cambridge, Kitchener and Waterloo. This presentation will focus on the Stage I Light Rail Transit (LRT) project between north Waterloo and south Kitchener. It is being implemented as a DBFOM project by GrandLinq Consortium, and AECOM is the lead designer for this project. The capital cost to construct is \$818M and the cost is split approximately equally between the Government of Canada, the Government of Ontario, and the Region of Waterloo.

Keywords: Light Rail Transit, Embedded Track, Load Cell, Grade Separation

1. THE HISTORY OF THE LRT PROJECT AND DRIVING ISSUES:

Presently, Grand River Transit (GRT), which services the cities of Kitchener, Waterloo, and Cambridge, travels over 12,000,000 km /year utilizing conventional low floor accessible buses, MobilityPlus specialized buses, and iXpress (Express) buses.

Regional growth is expected to add about 200,000 new residents over the next 20 years to the existing 570,000 population. ION will help to accommodate increased commuter traffic while concentrating new residential/commercial growth near the LRT corridor stops. This investment is expected to help reduce urban sprawl and demand for individual vehicle use.

Stage 1 LRT is scheduled to become operational in 2017 and is comprised of 19 km of light rail track from Conestoga Mall in north Waterloo to Fairview Park Mall in south Kitchener, with 19 individual stops. The stage I plan also includes a 17 km long adapted Bus Rapid Transit (aBRT) which connects the Stage I Fairview Park Mall LRT stop to the City of Cambridge Ainslie Street transit terminal.

2. DESCRIPTION OF WATERLOO LRT

The at-grade “low floor” LRT train is driven by 750 V supply via an Overhead Contact System. The system is 19 km rail track along a dedicated alignment, and incorporates concrete embedded, ballasted, and direct fixation track. Through downtown Waterloo and downtown Kitchener the NB and SB alignments split (along Caroline Street and King Street in Waterloo, and Duke Street and Charles Street in Kitchener).

The track is generally side-running along Regional roads, meaning that stops are located on both sides of the road rather in the median. Along the Waterloo Spur though, a median stop is provided at each stop location. Track is:

1. On-road from Conestoga Mall to the Waterloo Spur
2. Along existing Waterloo Spur corridor through the University of Waterloo and Waterloo Park to downtown Waterloo
3. On-road through Waterloo and Kitchener to Courtland Avenue/Huron Spur
4. Along existing CN Rail Huron Spur corridor to Hayward Avenue in south Kitchener

5. On-road along Courtland Avenue
6. Off-road along the hydro corridor parallel to Fairway Road to Fairview Park Mall

The system also includes 19 LRT Stops, 13 Traction Power Substations, 1 New Operations, Maintenance and Storage Facility, 1 Major Grade Separation plus 2 new bridges, 2 new culverts, structure rehabilitations of several bridges and culverts, and extensive new public infrastructure works.

3. KING STREET GRADE SEPARATION

The largest new bridge on the project is the King Street Grade Separation, which carries two CN tracks over King Street and the LRT. The existing crossing is at-grade. The crossing skew is 42° and the structure accommodates 3m wide walkways at CN track level on each side for a future Go Transit platform.

The RFP proposed a three-girder steel through plate girder structure. However, with the required skew, and CN restrictions on skewed steel girder bridges, the bridge ultimately put forward by GLC in the proposal submission was twin two-span skewed concrete rigid frame bridges supported on H-pile foundations. The method of construction was conventional, including a track diversion, extensive track protection, and large excavation for foundations, as the proposed alignment of King Street and the LRT under the heavy rail tracks is about 5m lower than the original grade.

Early in the detailed design stage, the possibility of using top-down construction was evaluated. The main reasons for considering the use of top-down construction were the resulting reduction of track protection required to construct the foundations and substructure, the reduced excavation for the foundations, and elimination of steel H-piles if caissons could be used. Although this had been contemplated during the proposal stage, there was insufficient time and information to be able to effectively determine whether this alternative was possible.

The geotechnical investigation indicated that very dense glacial till material was available at about 35m below existing grade. A 1.3m diameter test caisson with a load cell was constructed at the site to confirm the soil parameters used to calculate the capacities of the concrete caissons. The test caisson with load cell located near its base extended into this very dense glacial till. The load cell was hydraulically pressurized from the surface, simultaneously loading the pile section below which was resisted by end bearing resistance of the till, while the loading on the caisson above the load cell was resisted along the caisson's length by skin friction. As the load was applied, sensors measured the displacement of both the upper and lower pile sections which provided the individual end bearing and skin friction of the test pile.

The results of the load test confirmed that the concrete caissons could support the heavy rail loading of the proposed bridge, and so the alternative design concept was confirmed. The bridge design was modified to being supported on caissons and construction proceeded: caissons were installed for the piers, abutments, and wingwalls, concrete caps were constructed at the top of the abutments and pier, sufficient excavation was then undertaken to accommodate the construction of the deck, King Street was excavated under the deck, and facing walls were constructed on the exposed abutment and pier caissons. Retained soil system walls were installed to transition the embankments beyond the bridge.